

**THE SOUTHERN YELLOWJACKET, *VESPULA SQUAMOSA* (DRURY)  
(HYMENOPTERA: VESPIDAE) IN GUATEMALA, CENTRAL AMERICA**

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**Abstract.**—Southern yellowjackets, *Vespula squamosa* (Drury) were collected at sites in Guatemala, in the Departments of Baja Verapaz, El Progreso, and Zacapa. Collection localities ranged in elevation from 500 to 1,880 m. These locations were forested, or partially forested with some pasture land and coffee plantings, *Coffea arabica* L. Two active colonies of this wasp were collected and analyzed in May of 2006. The two colonies were subterranean, and the nests had 9 and 11 layers, respectively, of paper comb completely surrounded with external paper envelope. The two nests included 10,581 and 20,715 cells, with 2,818 and 6,105 workers, 203 and 313 queens, and 790 and 454 males respectively. Samples of queens from each nest were dissected. These included numerous queens that were mated and possessed mature eggs, as well as numbers of queens that were unmated and had no eggs. Workers from each nest showed no ovarian development. The nest sizes and populations of wasps for these colonies were within ranges of those reported for nests of this species in North America.

**Resumen.**—Se colectaron ejemplares de la avispa amarilla de tierra *Vespula squamosa* (Drury) en los Departamentos de Baja Verapaz, El Progreso y Zacapa, Guatemala. La altitud de las localidades muestreadas fue de 500 a 1,880 msnm. La vegetación fue de bosques, bosques y pastizales y plantaciones de café *Coffea arabica* Linnaeus. Se localizaron dos colonias activas de la avispa, las cuales se mataron, excavaron y analizaron en mayo del 2006. Las dos colonias fueron subterráneas, y los nidos tuvieron de 9 a 11 capas de panal de papel completamente cubiertos con una capa externa de papel. Los nidos constaron de 10,899 y 21,265 celdas; 2,818 y 6,105 obreras; 203 y 313 reinas; y 790 y 454 zánganos, respectivamente. Se disecaron 25 reinas y 25 obreras de cada nido. Se encontraron reinas que habían copulado y tenían huevos maduros, y reinas sin copular y sin huevos. Ninguna de las obreras de ambos nidos mostró desarrollo de ovarios.

**Key Words:** *Vespula squamosa*, yellowjacket, social wasp, Vespidae, Guatemala



The southern yellowjacket, *Vespula squamosa* (Drury), is widely distributed in North America from the states of New York and Wisconsin south to Florida and Texas, and through Mexico into Central America (Miller 1961, Akre et al. 1980, Hunt et al. 2001). The species is noteworthy among yellowjackets (*Vespula/Dolichovespula*) for its extensive north-south distribution and its behavioral and colonial plasticity. It is facultatively parasitic, primarily on the eastern yellowjacket, *Vespula maculifrons* (Buysson) (MacDonald and Matthews 1975, 1981, 1984), but much of its southern distribution does not overlap with that of *V. maculifrons* or other *Vespula* species (Akre et al. 1980). In northern Georgia and North Carolina, MacDonald and Matthews (1984) found it to be annual in its colony cycle, and monogynous, with a single queen. However, colonies of this same species occasionally become perennial and polygynous, and potentially enormous, in the far southeastern U.S. (Tissot and Robinson 1954, Ross and Matthews 1982, Pickett et al. 2001). *Vespula squamosa* nests are generally subterranean (MacDonald and Matthews 1984), but noteworthy examples of above-ground nests are reported (Tissot and Robinson 1954, Pickett et al. 2001).

Although *V. squamosa* ranges well into Central America, there is little information on its occurrence or biology south of the United States (USA). It occurs in Mexico in the states of Chiapas, Guerrero, Michoacán, Oaxaca, San Luis Potosí, Tamaulipas, and Zacatecas (Carpenter and Kojima 1997). There is a single record of this species in Guatemala, from Puerto Barrios, which is on the Caribbean coast in the Department of Izabal (Miller 1961, Krombein 1979, Carpenter and Kojima 1997). Hunt et al. (2001) reported *V. squamosa* at multiple locations in Honduras.

We report a summary of collection records for this wasp that indicate a broad distribution in Guatemala. We also report nest size, nest structure and location, and reproductive status of queens and workers obtained in the analysis of two active *V. squamosa* colonies in Guatemala.

#### MATERIALS AND METHODS

Initially, several specimens in the Entomological Collection at Universidad del Valle de Guatemala, in Guatemala City were recognized to be *V. squamosa* by P.J.L. Wasps were subsequently collected by net by the authors at field locations during 2005, 2006, and 2007. Also a flight intercept trap (6 m wide, one m deep, and 3 m tall) was used for one week in July 2007 near San Lorenzo, Zacapa, to capture wasps flying along a trail in a pine forest.

Two colonies of *V. squamosa* were located in May 2006 on a farm following conversations with the farm manager who knew of farm workers attacked by wasps. These colonies were killed with a pesticide, and the nests were excavated. The arrangements of combs were noted, and numbers of cells, numbers of cells with eggs, larvae, and cocoons, and numbers of workers, males and queens were recorded. Samples of queens from each nest was preserved in 80% ethanol, and were later dissected under a stereomicroscope to determine the presence of sperm in the spermatheca, mature eggs and fat in the gaster, wing wear, and brown age spots on the gastral tergites. Mature eggs were eggs greater than or equal to 1.0 mm in length (Reed and Landolt 2006). Wing wear and brown spots on the cuticle of the gastral tergites are indications of ages of queens typical of foundress queens in mature temperate latitude colonies (Duncan 1939, Spradbery 1973). A sample of 20 workers from each colony was also preserved in 80%



Table 1. Summary of *Vespula squamosa* collection records in Guatemala, providing Department, location, collection dates, and collectors.

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GUATEMALA, Zacapa, Sierra de las Minas, San Lorenzo, 16 May 1987, L. M. Giron. 1 male
GUATEMALA, Zacapa, Jones, Río Colorado, 500 m elev., 22 March 1996. 1 worker
GUATEMALA, Zacapa, San Lorenzo, Río Beguirel, 16 June 1996, M. Dix. 1 worker.
GUATEMALA, Zacapa, Arriba de la Union, 1,400 m elev., 22 December 1998. 1 worker
GUATEMALA, Zacapa, San Lorenzo, NE of Teculután, N15°04.86' W89°40.09', 1,880 m elev., 19 July 2007, P. J. Landolt, R. S. Zack, and J. Monzón. 3 workers.
GUATEMALA, Zacapa, San Lorenzo, NE of Teculután, N15°04.86' W89°40.09', 1880 m elev., 24 July 2007, P. J. Landolt. 1 worker, 2 males.
GUATEMALA, El Progreso, Morazán, Finca El Risco, 1,500 m, 19/20 May 2006. J. Monzón, P. J. Landolt, H. C. Reed, R. S. Zack, and K. N. Landolt. 8 workers.
GUATEMALA, Baja Verapaz, Cerca de Purulhá, Pantin-Salama Road, 1,500 m, 22 September 2005, José Monzón. 3 workers.
GUATEMALA, Baja Verapaz, Santa Rosa Road, near Purulhá, N15°14.32' W90°17.24, 18 May 2006, P. J. Landolt. 1 worker.
GUATEMALA, Baja Verapaz, Cerca de Purulhá, Camino a Pantin, 1,500 m, 2 July 2006, José Monzón, Orchanian, and Atamian. 1 worker.
GUATEMALA, Baja Verapaz, Cerca de Purulhá, Camino a Pantin, 1,700 m, 10–15 June 2007, José Monzón and Faustino Camposeco. 2 workers..

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ethanol, until they were dissected and examined for sperm presence and ovarian development.

Voucher specimens are deposited in the James Entomological Collection, Department of Entomology, Washington State University, Pullman, Washington, and Universidad del Valle de Guatemala, Guatemala City.

## RESULTS

*Geographical collection records:* Records for *V. squamosa* in Guatemala are summarized in Table 1. These records include specimens found in the Entomological Collection of Universidad del Valle de Guatemala in 2005, as well as specimens collected subsequently by the authors. Worker and male *V. squamosa* were collected in the Departments of Baja Vera Paz, El Progreso, and Zacapa (Table 1). These sites are in the interior uplands of Guatemala. Collection dates were throughout the year, but with too few records to develop hypotheses on seasonal patterns of abundance or colony development. Three worker wasps collected 22 September 2005 and one worker wasp collected 18 May 2006 in Baja Vera Paz

(Table 1) were on flowers of white ball acacia, *Acacia angustissima* (Miller) Kuntze. Worker wasps collected 19 and 24 July 2007 in Zacapa (Table 1) were within the flight intercept trap suspended across a trail. These were not captured in the killing jars of the trap, but rather were hand collected on the netting of the trap. Several other wasps that appeared to be *V. squamosa* were seen to enter and then depart the same trap. Other wasps collected (Table 1) were netted while in flight.

*Nest analyses:* The first nest (pasture colony) excavated was in a small cattle pasture with widely dispersed pine trees (*Pinus* sp.). This pasture was adjacent to an area of coffee, *Coffea arabica* L., with an overstory of broad leaf trees. The nest was ca 6 cm from the soil surface following a horizontal tunnel. The entrance hole at the soil surface was about 3 cm wide, and was 1/3 down into a one m deep by 2.5 m wide eroded gully. The nest, including envelope, was 50 by 17 cm across and 27 cm tall, and was comprised of 11 layers of horizontally stacked combs, but with much smaller comb pieces interspersed in between and alongside 11 larger or major combs. Combs were connected to one



Table 2. Composition of two subterranean colonies of *Vespula squamosa* from a coffee farm near Morazán, El Progreso, Guatemala. Elevation 1,500 m, 19/20 May 2006.

Location	Worker Cells				Queen Cells	Total Cells
	Empty	With Eggs	With Larvae	With Pupae		
Pasture Nest	3,451	3,256	5,895	7,563	550	20,715
Shrub Nest	881	2,126	3,130	4,126	318	10,581

another vertically by rigid paper struts and the entire arrangement of combs was enclosed in paper envelope. Areas of some combs had much of the cell walls missing (apparently chewed down by the wasps), and some areas of comb had cells covered over by paper similar to the external envelope of the nest. The nest of this colony contained 20,715 cells (Table 2). Five hundred and fifty of those cells were larger cells or queen cells. Six thousand one hundred and five workers, 313 queens, and 454 males were collected inside and beneath this nest (Table 3). The colony was very active, with nearly 83% of the cells occupied by wasp eggs, larvae, or pupae.

The second nest (coffee shrub) excavated was in a mature planting of coffee with an overstory of broad leafed trees. The nest was underground at the base of a coffee shrub and the site was covered by several cm of leaf litter and the roots of the coffee plant. The entrance hole at the surface was 3.0 by 5.5 cm and was ca 30 cm from the base of the shrub. The tunnel from the soil surface to the nest was nearly vertical and was 7.0 cm long. The nest structure was generally as described for the previous nest, and was completely enclosed by paper envelope.

Table 3. Number of adult *Vespula squamosa* wasps collected in and around the excavated nests from a coffee farm near Morazán, El Progreso, Guatemala. Elevation 1,500 m, 19/20 May 2006.

Location	Number of Wasps with Nest			Total
	Workers	Queens	Males	
Pasture Nest	6,105	313	454	6,872
Shrub Nest	2,818	203	790	3,811

There were nine horizontal combs of cells stacked vertically. The nest including the envelope was 26 by 37 cm across horizontally, and 40 cm top to bottom. The nest contained 10,581 cells and 317 of those were larger queen cells (Table 2). Two thousand eight hundred and eighteen workers, 203 queens, and 790 males were within and beneath the nest (Table 3). Over 79% of the cells were occupied by wasp eggs, larvae, or pupae.

*Queen dissections:* Twenty-two of the queens collected from the nest in the pasture were dissected. All of these queens had developed ovaries with mature sized eggs, and sperm were found in the spermathecae of 21 of these queens. All of the 22 queens had small amounts of fat in the gaster, visible as a thin lining along the inside of sterites and tergites. The number of mature eggs per queen was  $22.4 \pm 12.8$  ( $\pm$  SE), ranging from 4 to 42. Only one queen, with 42 mature eggs, had brown spots on gastral tergites.

Twenty of the queens collected from the nest found in the coffee planting were dissected. All of these queens were mated, but only 3 of the 20 had well developed ovaries. The remainder either possessed undeveloped ( $n = 9$ ) or slightly developed ( $n = 8$ ) ovaries. Undeveloped ovaries had filamentous ovarioles with no developed eggs, while slightly developed ovaries had some development of eggs but none mature in size. The number of mature eggs per queen was  $2.95 \pm 0.93$  ( $\pm$  SE), ranging from 0 to 17. Five of these queens had little fat in the gaster while 15 had moderate amounts of fat present, visible as globules protruding into the inside of the gaster. None of these queens had



brown spots on gastral tergites or visible wing wear.

None of the dissected workers from either the pasture nest or the coffee nest possessed mature eggs in the ovaries or sperm in the spermathecae.

#### DISCUSSION

The collection records presented here indicate a distribution of the southern yellowjacket in the central highlands of Guatemala. This wasp could potentially have a fairly continuous distribution from Mexico, through Guatemala and into Honduras. Records in Mexico include the southern state of Chiapas (Carpenter and Kojima 1997), which borders highland areas of Guatemala to the north. Records in Honduras are in the western highlands east of these areas of Guatemala (Hunt et al. 2001).

Collection records indicate an elevation range from 500 to 1,880 m, although most collection sites were at the upper end of that range. *Vespula squamosa* collection sites visited by the authors were characterized by the abundant presence, if not dominance, of tree species typical of more temperate forests, such as *Pinus* (pine), *Quercus* (oak), and *Liquidambar* (sweetgum). This observation is similar to that made by Hunt et al. (2001) for the same yellowjacket species in Honduras. Coincidentally, Akre et al. (1980) indicated that the southern yellowjacket in the USA is normally found in areas of pine forest, and MacDonald and Matthews (1984) reported that colonies of this species were in mixed pine/oak forest, and not in exclusively hardwood forest in Georgia. The exception is the single collection reported prior to this report, from Puerto Barrios on the Caribbean coast of eastern Guatemala (Miller 1961), which is a low elevation site not characterized by pine or oak forest.

To our knowledge, our information on the nests we excavated provides the first

descriptions of colonies of *V. squamosa* south of the USA. MacDonald and Matthews (1984) described annual monogynous colonies of this wasp in the states of Georgia and North Carolina. Very large perennial and polygynous nests have been found in southern Georgia, Florida (Tissot and Robinson 1954, Akre et al. 1980, Ross and Matthews 1982) and most recently in Alabama.

The sizes of these two Guatemalan nests are well within the size ranges reported for mature colonies of this species in the USA. The colony from below the coffee shrub was similar in size to the largest of mature annual colonies in northern Georgia (MacDonald and Matthews 1984). The colony from the cattle pasture was about twice as large as any of the annual colonies that MacDonald and Matthews (1984) found in northern Georgia, but was small in comparison to presumed perennial nests from the southeastern USA (Tissot and Robinson 1954, Ross and Matthews 1982, Pickett et al. 2001).

Numbers of wasps found within the nests and in the nest cavities were also within reported ranges of populations for mature colonies. For the coffee nest, numbers of workers, males, and queens were similar to those in mature annual nests in Georgia (MacDonald and Matthews 1984), while the pasture nest possessed twice as many workers as the largest temperate annual nests found by MacDonald and Matthews (1984) in northern Georgia. Unfortunately, counts of worker wasps have not been made or reported for any of the perennial, polygynous colonies of *V. squamosa*.

Numbers of queens within these nests in Guatemala were similar to those of mature annual colonies in northern Georgia and North Carolina (MacDonald and Matthews 1984). The reproductive state of the queens in the Guatemalan nests was similar to that reported by Ross and Matthews (1982),



who found numbers of reproductively mature and mated queens in two perennial nests in Florida.

These two Guatemalan nests then appear to be polygynous in that they possessed multiple queens capable of egg laying. However, the functional reproductive situation in those nests is not fully understood. Functional queens of annual monogynous *Vespula* colonies are typically physogastric with large numbers of eggs (Spradbery 1971, 1973). However, none of these queens in the Guatemalan nests appeared physogastric, and none were similar in appearance to late-season queens of annual *Vespula* colonies with frayed wings and brown "age spots" on the cuticle. A similar situation is reported for a colony of *V. squamosa* in Florida by Ross and Matthews (1982) with 101 of 114 queens possessing developed ovaries, but none with many eggs and none with an extended gaster evident of abundant presence of eggs. Ross and Matthews (1982) appeared reluctant to consider these "functional" queens, but rather indicated they might be overwintering in the nest, despite the somewhat developed ovaries with mature eggs. New queens of *Vespula pensylvanica* (Sausure) in California may overwinter within subterranean nests (Vetter and Vischer 1997) and queens of that species may enter winter with some ovarian development (Reed and Landolt 2006). It is not clear if these *V. squamosa* queens in Guatemalan colonies were established egg-layers in those nests, or if they were only temporarily present in the nests.

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